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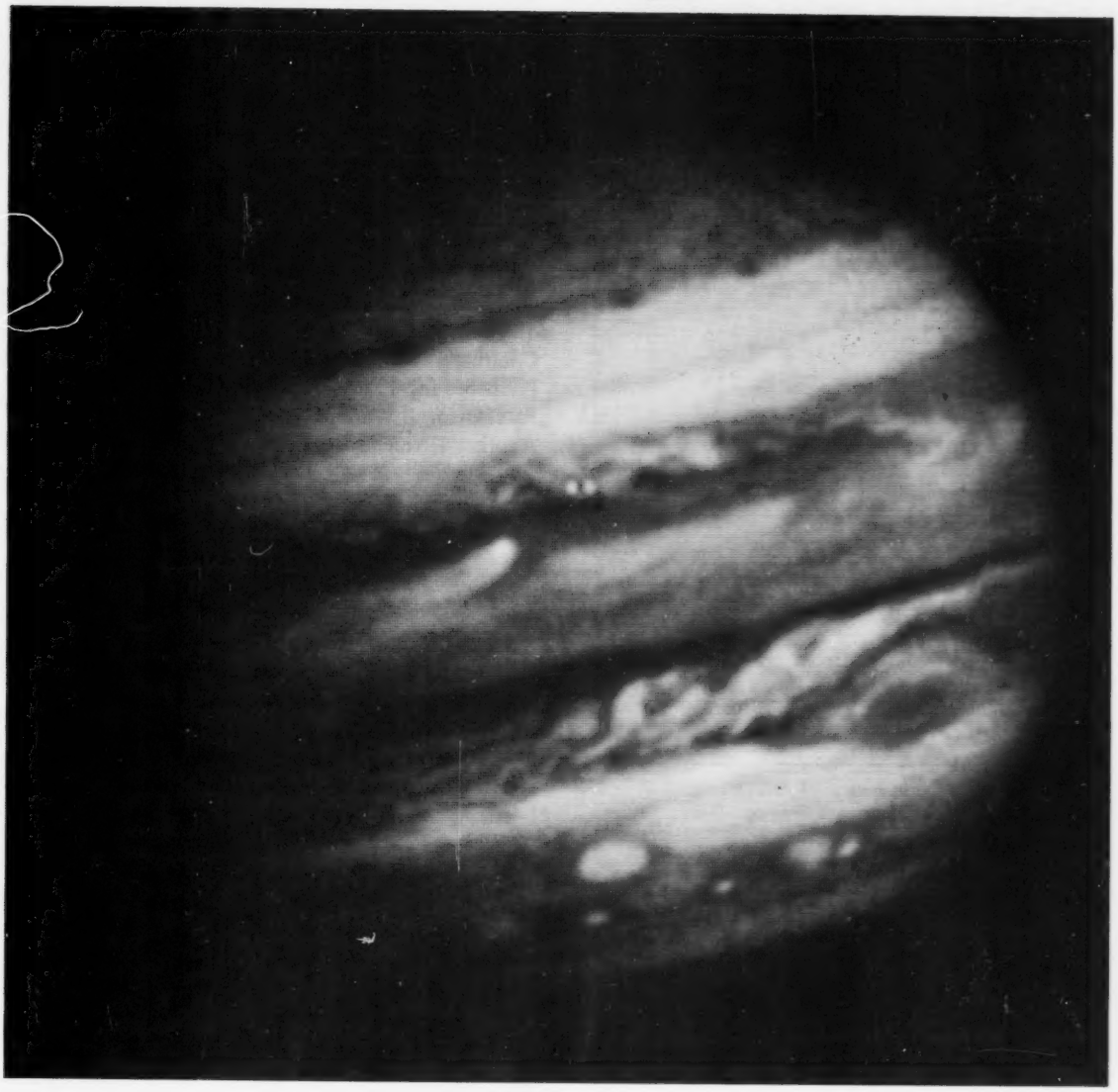

Cover

New View of Colossus Among Planets—Revealing more detail than could be provided by even the best groundbased telescope, this Voyager 1 image of Jupiter was taken Dec. 10 from 52 million miles away. It shows the Great Red Spot (lower right) surrounded by a turbulent atmosphere. The entire visible surface of Jupiter is made up of multiple layers of clouds composed primarily of ammonia ice crystals tinted by small amounts of materials of unknown composition. Near the center is a bright convective cloud and an associated plume which has been swept westward (to the left) by local currents in the planet's equatorial wind system. Below and to the left of the Great Red Spot is a white oval cloud, one of three that formed nearly 40 years ago in the south temperate region. Largest of the planets, Jupiter is 1,200 times larger than Earth. This picture was taken by a camera equipped with a 1,500-millimeter focal-length telescope.

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Table of Contents

NASA Launches Canadian Satellite 3
Agreement Reached on U.S.-China Cooperation. 4
Five Begin Training for Spacelab Duty 4
Solar Energy Reporter Now Operating 5
Sounding Rocket Launched 5
The Views from Viking 6
Wright Brothers Exhibit Opens at NASA Visitor Center 6
Dialogue with Some NASA Newcomers 6
Earth Terrain Contouring by Satellite 10
Advanced Propellers to Be Tested 11
Spacelab Task Assigned to KSC 11
Geological Expedition to the Egyptian Desert . 12
Launches and Space Events in 1979 12
Presidential Recognition 13
A Look at History—from "Flyer" to Viking in Only 75 Years 14
NASA to Brief Educators 16
Book Published on Women in Aviation 16
GE to Build Improved Landsat 16
New Director for TDRSS 17
Terrell Resigns 17
Goddard Scientist Honored 17
The Skylab Story 18
Contractor News 26
Launches for 1979 27
Patents for Inventions 27
Another Dividend from Air and Space 28

NASA Launches Canadian Satellite

Canada's most advanced domestic communications satellite, Anik–B, was launched by NASA from Cape Canaveral on Dec. 15. The United States will be reimbursed $19.2 million by Canada for the Delta launch vehicle and launch services.

Anik–B is the fourth domestic communications satellite to be launched by NASA for Telesat Canada which owns and operates the satellites as the country's Domestic Communications Satellite System. (Anik is the Eskimo word for "brother.")

The new satellite is to replace Anik–A2 (launched in 1972) now positioned at 109 degrees west longitude over the equator, due south of California. With a design lifetime of seven years, Anik–B will provide point-to-point voice, TV and data communications traffic to Canada's 10 provinces.

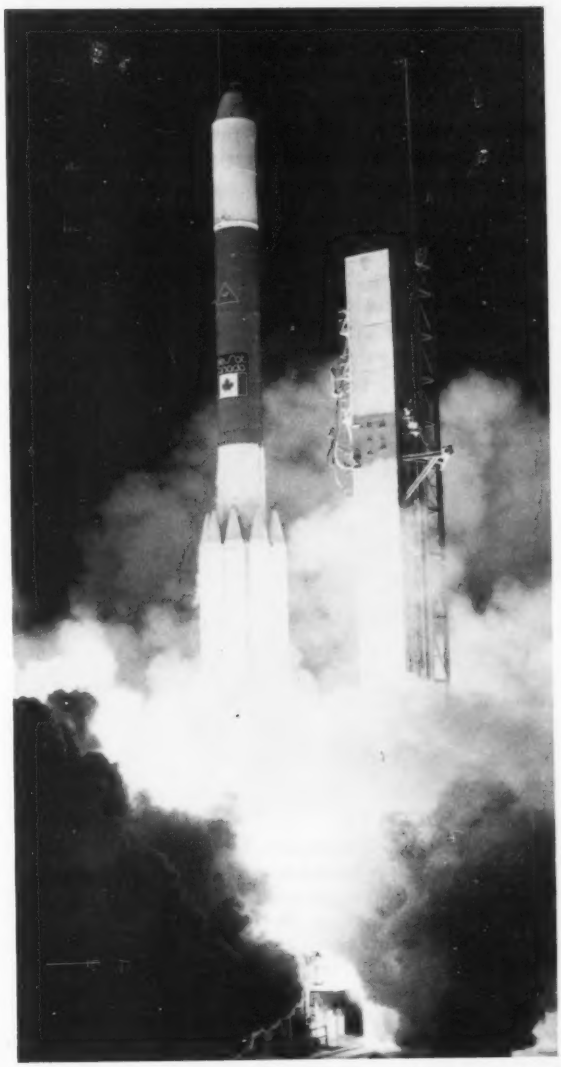
In addition to 12 commercial channels in the 6 and 4 gigaHertz frequency bands, Anik–B has four channels for operation at the 12 and 14 GHz frequencies. The entire capacity of the satellite's higher frequency bands will be leased to Canada's Department of Communications for two years with an option for two additional years' use. These channels will be used for a series of 14 pilot projects which stem from the Communications Technology Satellite, a joint U.S.-Canadian experimental satellite. The projects include social experiments such as medicine, education, conferencing and Eskimo broadcasting, all intended to further evaluate satellites as a means of reaching remote locations equipped with small ground stations. Other purely technical projects are designed to produce experimental information about such subjects as signal propagation as well as power generation and usage.

The Delta launch vehicle placed Anik–B into a highly elliptical orbit ranging in altitude from 185 to 35,787 kilometers. The satellite weighed 922 kilograms at liftoff, including an attached solid fuel rocket motor. Anik–B weighs 474 kg in orbit.

Several days after launch, at the seventh apogee (high point) of the elliptical orbit, the attached solid fuel rocket motor was ignited to circularize the Anik–B oribit at its geosynchronous altitude. At that altitude, the velocity of the satellite matches the rotational speed of the Earth and Anik–B remains over the same location on the equator. Small gas jets keep the satellite on "station" and properly oriented towards the Earth to receive and retransmit signals.

About 25 minutes after liftoff, control of the Anik–B mission was transferred to Telesat's Satellite Control Center, headquartered in Ottawa, after separation from the Delta vehicle. Tracking, transmission and reception of data is provided by the Telesat Earth station near Allan Park, Ontario, about 130 km west of Toronto.

The Delta is managed by the Goddard Space Flight Center, for NASA's Office of Space Transportation Systems. NASA's Kennedy Space Center is responsible for launch operations management. Prime contractor for Delta and launch operations is McDonnell Douglas Astronautics Co., Huntington Beach, Calif. The Anik–B was developed and built for Telesat Canada Ltd., Ottawa, Ontario, Canada, by RCA Astro-Electronics, Princeton, N.J.



Agreement Reached on U.S.—China Cooperation

A delegation from the People's Republic of China began on Nov. 28 holding discussions with United States officials regarding possible U.S.-Chinese cooperation in the peaceful utilization of space technology. The U.S. delegation was headed by Administrator Dr. Robert A. Frosch, and the Chinese delegation was headed by Dr. Jen Hsin-min, Director of the Chinese Academy of Space Technology.

The discussions were a follow-up to the visit of Dr. Frank Press, the President's Science Advisor, to China last July. In conjunction with the Washington discussions, the Chinese delegation, accompanied by NASA representatives, visited several NASA centers and U.S. aerospace industrial establishments.

As a result of the discussions, an informal agreement has been reached in principle on U.S.-Chinese cooperation in the development of the civil communications system of the People's Republic of China. This involves the purchase by China of a U.S. satellite communications system, including the associated ground receiving and distribution equipment. The space portion of the system will be placed in geostationary orbit by the U.S., with continued operation to be carried out in China.

Visitors from China—A delegation from the People's Republic of China are briefed by astronaut Karol J. Bobko (far left) during a tour of the mission simulation and training facility at the Johnson center. The group is shown in the area containing control panels and consoles supporting Space Shuttle mission simulators. Some 25 persons including representatives, interpreters and escorts, visited several other facilities during their Dec. 13 stopover, part of a scheduled tour that took them to several other NASA facilities around the country and to several industrial centers.

Similar informal agreement in principle has been reached regarding the purchase by China of a ground station capable of receiving Earth resources information from U.S. Landsat remote sensing satellites, including the Landsat–D now under development.

The Chinese delegation remained in the United States until mid-January to carry on further technical discussions with U.S. government officials and representatives of industry.

Both sides expressed satisfaction with this first round of talks and agreed to hold further talks to work out the details of the informal agreements as well as to consider other forms of civil space cooperation which could be of mutual interest and benefit.

Five Begin Training for Spacelab Duty

Five European and American scientists selected last July to operate the experiments on NASA's first Spacelab mission began training in the United States in January.

A training tour will take them to six U.S. cities and two in Canada, to prepare for operation of the equipment associated with a number of scientific investigations to take place on the laboratory when it is carried into Earth orbit aboard the Space Shuttle in 1981.

The selection and training of these scientists to fly in space represents a departure from earlier NASA practices. They are not career astronauts, but were chosen for the mission by the scientists who devised the experiments to be flown. One will be the first Western European to fly in space and it will be NASA's first attempt to carry someone from a country other than the United States into space.

Three of the payload specialists, as they are called, are from Europe. The first Spacelab mission, like the building of Spacelab itself, is a joint venture of NASA and the European Space Agency, a consortium of countries. Of the five men training for the mission, two—a European and an American—will actually go into space aboard Spacelab 1. The other three will operate the ground-based experiment equipment and will support the two in orbit. Selection of the payload specialists who will actually fly will not be made until later in the training cycle.

The payload specialists for Spacelab 1 are:

- Michael L. Lampton, University of California, Berkeley.
- Byron K. Lichtenberg, Massachusetts Institute of Technology.

- Ulf Merbold, German, Max Planck Institute, Stuttgart.
- Claude Nicollier, Swiss, European Space Technology Center.
- Wubbo Ockels, Dutch, Groanigan University, Netherlands.

All five have just returned from Europe, where they had been in training since October, learning to operate the experiments to be placed on Spacelab by European scientists.

The payload specialists began their first American training tour Jan. 9, with a four-day session at the Marshall Space Flight Center. The Marshall center is NASA's lead center in the development of Spacelab itself, and is managing the first three missions.

The payload specialists' training programs take place in Redondo Beach, Calif.; Huntsville, Ala.; Houston (Johnson Space Flight Center); Philadelphia, Pa.; Boston, Mass.; Montreal and Toronto, Canada; and Palo Alto, Calif.

They will return to Huntsville on March 22.

Forty instruments will be flown aboard Spacelab 1. The science payload is about equally divided between NASA and ESA experiments in terms of weight, power, and volume requirements. Investigations will be conducted in stratospheric and upper atmospheric physics, materials processing, space plasma physics, biology, medicine, astronomy, solar physics, Earth observations and in technology areas such as thermodynamics and lubrications.

The Marshall center manages training activities in the U.S. as part of its overall management responsibility for the first three Spacelab missions. ESA manages training activities in Europe.

Solar Energy Reporter Now Operating

Residents of north Alabama now can begin receiving information daily on the amount of sunshine falling on the area—solar energy which could be used for heating and cooling—as a result of a joint effort of the Marshall Space Flight Center and the National Weather Service (part of NOAA).

"Solar Energy Reporter" equipment provided by NASA, and a pyranometer provided by the Weather Service, have been installed at the Huntsville-Madison County Airport. The pyranometer, which measures Sun intensity, is mounted on the roof of the Weather Service building at the airport. The reporter equipment is part of a panel of instruments inside the building.

The equipment will provide information day or night by commercial telephone line on the amount of solar energy—in kilowatt hours per 46 square meters—generated the previous day, the accumulated energy for the current day up to the time of the call, and the rate of generation at the moment. The equipment consists of the pyranometer, an integrator to accumulate measurements throughout the daylight period, a voice synthesizer to convert binary numbers to voice sounds and report the results in English over the telephone, and an automatic interface between the reporter and the telephone.

A person needing the information will begin by dialing a local number. The automatic connection will be made and the voice synthesizer activated. The caller will then listen to three sets of numbers, with a pause between sets.

The numbers will be meaningful to persons who have been instructed on their interpretation.

For example, a call during the day might bring as an answer, "Two five zero, one three four, four nine." The "two five zero" would represent a partly cloudy previous day with solar energy of 250 kilowatt hours per 46 sq. m., the "one three four" the Sun energy accumulated up to that moment the current day (134 kilowatt hours per 46 sq. m.), and the "four nine" the intensity typical of a summer day at noon.

A call at night might bring, "Three five zero (a bright, sunny previous day), four zero (a dark day today), and zero (nighttime)."

Sounding Rocket Launched

A Nike-Tomahawk 18.1024 UE was successfully launched from the White Sands Missile Range, on Dec. 11, 1978. The prime purpose of the experiment was to study the neutral composition of the lower thermosphere. The experimenter was Dr. A. O. C. Vier from the University of Minnesota. The instrumentation of the payload consisted of two mass spectrometers, one mounted in the nose of the rocket and pointing forward, the other mounted looking out the side. Both instruments were sealed after calibration. Predicted apogee was 230 km and actual apogee was 228 km. All data were recovered. Project manager was David Detwiler and systems engineers were William Martin, mechanical; Greg Demetrick, instrumentation; Richard Caskey, electrical.

The Views from Viking

There are 200 high-quality photographs are presented in "The Martian Landscape," a handsome new book just published by NASA. The pictures were chosen and the text written by members of the Viking Lander imaging team, and they present a dramatic summary of that milestone in planetary exploration. Stereo spectacles are provided in a pocket in the back of this remarkable book for the nineteen stereo pairs in the volume. The photos, which include mosaics, panoramas, close-ups and color, are expertly captioned by members of the Lander imaging team, often with analytic interpretive detail.

A remarkable 19,000-word "anecdotal history" of the Viking Project opens the volume. Written by Professor T. A. Mutch of Brown University, the geologist leader of the Lander imaging team, this introduction gives a rare inside glimpse into the ways of planetary exploration in the 1970s. Mutch tells how the mission was planned and brought into being, with a vivid description of the eight years of planning, designing, and testing that preceded the first successful "soft" landing on Mars.

He tells how the cameras were engineered and built to exacting standards, and recounts many of the sickening difficulties—some seeming almost intractable and others ludicrous—encountered before Viking achieved its dazzling success. To read Mutch's graphic account is to sense the years of conflict and tension, as well as drudgery and plain hard work that underlie the climactic excitement of modern planetary exploration.

"The Martian Landscape," NASA SP–425, is an 11½ by 14 inch hardcover book available for $12 from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. The GPO stock number is 033–000–00716–7.

Wright Brothers Exhibit Opens at NASA Visitor Center

To commemorate the 75th anniversary of the first successful powered flight at Kitty Hawk, N.C., a new exhibit opened in December at the Langley visitor center. The exhibit includes a model of a section of the wing of the Wright Brothers' aircraft and a small scale model of the aircraft, as well as pictures of the historic first flight and a slide/tape presentation.

Dialogue with Some NASA Newcomers

This article introduces some new members of the NASA team who are several months into a two-year program at JSC to equip then for 7- to 30-day trips aboard the Space Shuttle.

Many people take a sort of perverse pleasure in discovering little flaws in their superstars, perhaps because everybody is only too well aware of personal weaknesses or faults. It's nice to know that others aren't perfect either.

It would make for a livelier article to reveal feet of clay in the new breed of astronauts and mission specialists in training at the Johnson Space Center, but such are not immediately evident. The group seems singularly blessed with brains, personality, physical attractiveness, a sense of adventure, stamina and superior health, and a fierce determination to overcome whatever obstacles might stand in their way. Their eyes are definitely on the stars, and one comes away with the notion that it would take a Sherman tank to deflect their determination to be aboard the Space Shuttle.

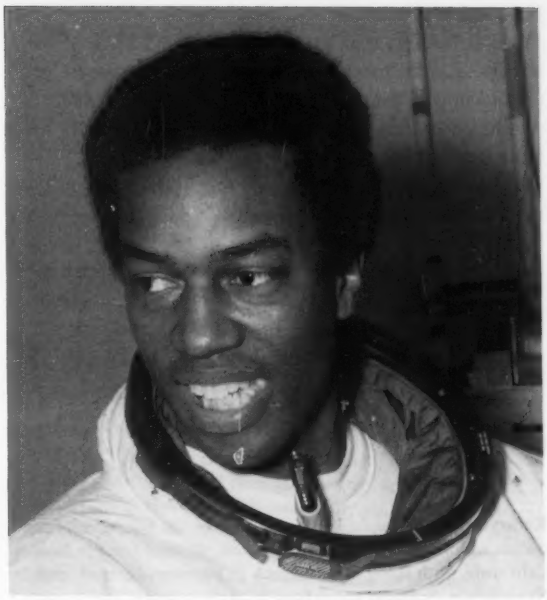
During interviews, the trainees are responsive and outgoing. They share certain characteristics and a like thread runs through their conversations as they describe reactions to their jobs and the NASA training program. Though much has been made in published material about the six women selected for astronaut duty, their attitudes seem no different from those of their 29 male counterparts.

Several questions brought forth comments similar enough to be incorporated in a composite answer.

How does an ordinary training day go? "Each of us is assigned to one of the older astronauts. He is our teacher, acquainting us with the many technical problems involved in spacecraft operation. A typical daily schedule might consist of a pilot safety meeting; working at technical assignments; classroom study covering many subjects; flights out of nearby Ellington AFB on T–38 planes [most candidates are experienced pilots, some with as many as 16 years of flying]; practicing techniques related to ejection from a plane over water; a period in the gym—running, weightlifting (women, too), cycling, playing handball, basketball or volleyball, whatever we choose to do. One of the important aspects of our training is the familiarization briefing in which different NASA specialists brief us on the design, operation, and handling of the Shuttle orbiter, to promote a fundamental feel for it."

Considering the exciting fields in which many candidates were working specialists—medicine, surgery, test piloting, underwater expeditions—is the schooling boring? Overly demanding? "Definitely not boring, if anything more exciting than we had anticipated. Some of us, even highly experienced former test pilots, are astonished at the amount still to be learned. 'The mountain seems very high when you're at the bottom.' Some of us find it easier to fly jets than conventional aircraft. The flight training right now may be the easiest part—when the training becomes more specifically technical, it might be more difficult."

Dr. Rhea Seddon, 30, a native of Murfreesboro, Tenn., practiced medical surgery before joining NASA, had planned to go on to plastic surgery. She is particularly interested in "surgical nutrition" (various systems of feeding people intravenously), which she calls an exciting new medical field. Seddon took her B.A. in physiology at the University of California at Berkeley and her M.D. from the University of Tennessee College of Medicine. She says she's pleased with the attention she and the other women astronauts get from the press, adding: "It shows people how well women can adjust and that they can readily handle the same jobs as men. I like the attention, but maybe I'm a ham."



Major Guion S. Bluford, Jr., 36, comes from Philadelphia, says he had had a lifelong interest in aircraft, now in space. He came to NASA after six years as an Air Force pilot, 144 combat missions, and more than 2,200 hours of jet flight time. He holds a Master's Degree and Ph.D. in aerospace engineering. Says he was surprised and very happy to be an astronaut finalist.

Are the physical requirements too demanding, particularly on the women? "We haven't come up against anything we haven't been able to handle. Most of us work hard to keep in shape, but mostly because we like to. We run a lot [individually 20 to an incredible 70 miles a week] and we play racquet and ball games. We sail or scuba dive. But we aren't required to have superhuman strength and endurance, only generally good conditioning. Our physical condition and effort are measured against our individual capabilities. We women can be very adaptable—if something is too heavy to lift, we figure out some other way to do it."

What about your instructors? As seasoned astronauts themselves, do they seem perfectly happy to be teaching a new generation, some of them women? "They have leaned over backward to be helpful to *all* of us. If they have any adverse reactions to the female astronauts, they keep them well hidden. These veterans really make us feel at home. They treat us as people new to a new program *should* be treated—nobody puts any of the newcomers down. That is true of both sexes, minority people, across-the-

board. It's good to find a whole group of people, those at NASA, who are truly interested in what they are doing, true masters of their jobs and anxious to share knowledge. A certain amount of resentment would be understandable since some of these fellows have been in the space program for 10 or 12 years and have never been on a space mission, while novices like us are almost guaranteed flights on the Shuttle. They *must* feel a twinge at times, but they are most unselfish and totally helpful, really dedicated. Their attitudes seem to reflect those of other NASA people and probably have a lot to do with the success so many of the NASA programs have had."

Dr. Judith A. Resnik, 29, grew up in Akron, Ohio, says she wishes the term "astronaut *candidate*" could be dropped. She, for one, has no intention of "washing out" or otherwise being eliminated from the Shuttle program. Resnik holds a B.S. and a Ph.D. in electrical engineering. Pre-NASA, she was a senior systems engineer. She is a classical pianist and an aircraft pilot in her spare time.

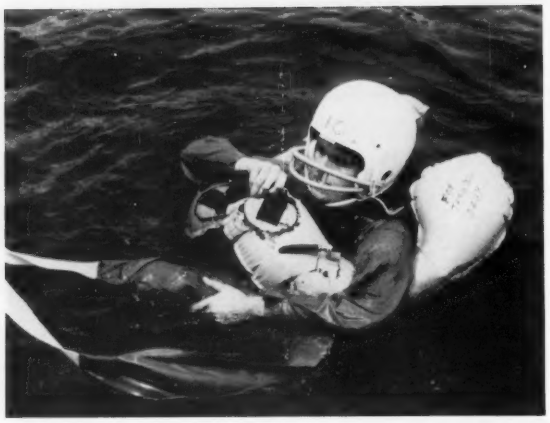
Kathryn D. Sullivan, at 26 years is one of the youngest of the trainees. Born in New Jersey, she spent most of her life in California, with study and research in Norway, Iceland, and Nova Scotia. Sullivan specializes in earth sciences and marine geology, and has served on a number of ocean research cruises. She earned her B.S. from the University of California at Santa Cruz and her Ph.D. (geology) from Dalhousie University at Halifax, N.S. A linguist, Sullivan speaks fluent French, German, Swedish, Norwegian and Danish. Her brother, a jet craft pilot, also applied for duty with the astronaut program but was not a selectee. Sullivan says he plans to keep on trying.

Dr. Ronald E. McNair, 28, comes from Lake City ,S.C., and is a specialist in lasers and in molecular spectroscopy. He won his B.S. in physics from North Carolina A&T State University, his Ph.D. in physics from the Massachusetts Institute of Technology. He was Presidential Scholar, a Ford Foundation Fellow, a National Fellowship Fund Fellow and a NATO Fellow, and he studied laser physics at the Ecole Déte Theorique Physique at Les Houches, France. On the side, McNair is a saxophonist, a teacher of karate, a boxer, a fisherman and a cook. Despite his impressive academic record, McNair says his early education was "catch-up all the way . . . I learned most of my high school science on my own. I was a hungry kid, academically."

Dr. Anna L. Fisher, *nee* Tingle, 29, was born in Albany, N.Y. but looks upon San Pedro, Calif. as home, Recently married, she and her husband specialize in emergency medicine. After receiving her B.S. in chemistry and her M.D. from the University of California, she interned and went into private practice in Los Angeles. The Fishers expect to continue practicing emergency medicine, she only a few times a month, after their Texas licenses are obtained. Her husband also applied for Space Shuttle duty, but was not a selectee. "No, he's not the least bit resentful," she says. "He's expanding his studies and he says that the next time around, he'll be better qualified for the job."

Dr. Jeffrey A. Hoffman, 34, is an astronomer born in Brooklyn, N.Y., who grew up in Scarsdale, N.Y. He earned his B.A. in astronomy at Amherst College and his Ph.D. in astrophysics at Harvard University. The author of numerous scientific articles, he left a research job at MIT to join the astronaut program. Why? "My initial reaction, pure and simple, was that all my life I wanted to be an astronaut."

Capt. Ellison S. Onizuka, 31, born in Kona, Hawaii, was one of 134 Air Force nominees for Shuttle duty. As a flight engineer going to test pilot school at the Edwards Air Force Base, he watched the Space Shuttle being put through the important approach and landing tests at nearby Dryden center. Onizuka received his B.S. and M.S. in aerospace engineering at the University of Colorado. He served with the Air Force from 1970 until his present NASA assignment. He likes working with NASA people, believing that: "They are dedicated and really know what they are doing."



Dr. Shannon W. Lucid, *nee* Wells, calls herself, at age 35, "the mommy of the group." She was born in Shanghai, China, of missionery parents, but calls Bethany (Okla.) her home town. Lucid holds a B.S. in chemistry, an M.S. and a Ph.D. in biochemistry, all three earned at the University of Oklahoma. She has taught and worked at various medical establishments in Oklahoma since 1963, and she holds a pilot's license. Married to Michael F. Lucid of Indianapolis, she is the mother of three children. She says her children "couldn't care less" about her new status, that they are "more interested in whether dinner is on the table on time and in telling about their own daily adventures."

Considering that most of you had intensive training in other fields, how did you happen to enter NASA service as an astronaut candidate? "Dreamed about it all my life, from the first time I ever saw a NASA astronaut on TV, but it seemed like only a fantasy. My husband and I both applied as soon as we heard about the program. Now it's like a dream come true."

"I flew for the first time when I was five and was hooked. Wanted to be part of the space program since I was a kid,—but when I was a kid 20 years or so ago, there wasn't that much of a space program."

"I thought ocean-going research cruises a very exciting thing, but going into space must be a hundred times more so."

"I had a lifelong interest in aircraft, loved my Air Force job, came to be interested in moving forward into the space program and found my chance with Space Shuttle. I was surprised to be a finalist since I found, after various tests, that the competition was very *stiff*. I want to get out and sell the space program, that will give me an opportunity to give something back for the opportunity."

"I had a big interest in space from childhood on, but never really thought I or other women would have a chance. Space, to me and for me, was a pretty farfetched idea. I found about the Shuttle program from a colleague, and immediately addressed a query to NASA, Houston, Texas. In retrospect that seemed like a pretty silly way to go about it. I got an immediate answer and that was it for me—a whole new career!"

"I knew a lot about the Shuttle program, having worked close to it as a test pilot. I was surprised when I learned that I had been selected. I wanted it in the worst way, but figured age might rule me out (I'm a year short of 40). I love the program but don't consider it particularly 'glamorous.' I came to fly an airplane and that's what I'll be doing, I guess."

"Pure and simple, I always wanted to be an astronaut. I will give up anything for that."

Earth Terrain Contouring by Satellite

Radar altimeter measurements from an experimental oceanographic satellite have resulted in an unexpected technological breakthrough. For the first time, Earth terrain contouring has proven feasible from a satellite microwave sensor with an accuracy comparable to conventional ground and aerial surveys used for small-scale mapping.

In an experiment sponsored by NASA's Wallops Flight Center, terrain contouring has been accomplished using GEOS–3 (Geodynamics Experimental Ocean Satellite) radar altimeter measurements from a height of 840 kilometers above the Earth's surface.

The demonstration of terrain topographic mapping took place over the San Joaquin Valley of southern California. Nineteen GEOS–3 passes over the valley resulted in terrain elevation mapping for 40,000 square km. Comparison of the satellite-derived contours with U.S. Geological Survey small-scale topographic maps of the valley shows agreement to within one meter.

As GEOS–3 circles the globe at a velocity of 7 km/sec, the radar altimeter points vertically down towards the Earth. The distance between the satellite and the Earth's surface is measured with a precision of 50 centimeters. As the satellite passes over a hill, the measured distance is shorter; over a valley, it is longer.

Because of the nature of radar backscatter and since the altimeter was intended as an ocean-sensing system, the acquisition of meaningful data over land was unexpected. The altimeter is designed primarily to measure ocean variables, therefore the measurement of terrain variations is restricted necessarily to

smooth or gently rolling topography, such as a coastal plain, interior plain or valley.

The overland results from GEOS–3 indicate that a satellite-borne altimeter in the future could be designed to provide terrain elevations in more rugged areas, at an accuracy level sufficient to satisfy many small-scale mapping requirements at a cost competitive with conventional methods. The technique would be particularly useful in remote areas of the world, such as arctic and desert regions where conventional surveying is difficult and expensive.

The GEOS–3 was launched in April 1975 with an expected lifetime of one year. The original oceanographic objectives of the mission all have been accomplished, and all systems on the spacecraft are still functioning. Currently the satellite altimeter measurements are being used in near-real time to provide ocean wave heights, wind speeds at the air-sea interface, ocean current boundaries and velocities, and sea ice locations.

Advanced Propellers to Be Tested

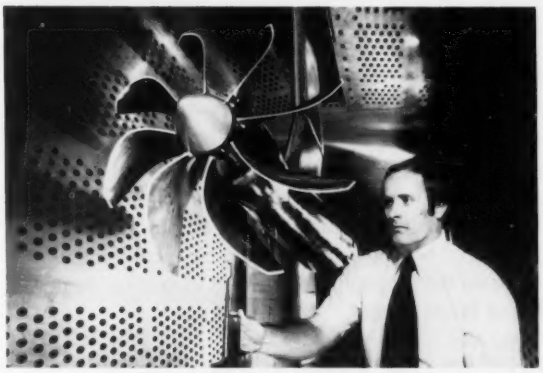
Flight tests of several advanced propeller models will be conducted by the Lewis Research Center and the Dryden Flight Research Center. The propellers to be tested are eight- and ten-bladed and are intended for new, high-speed aircraft of the future with better capabilities for fuel conservation.

The Lewis center already has measured the aerodynamic performance of scale models about one-seventh the real size in its wind tunnel at a simulated cruise speed of 855 kilometers per hour and an altitude of 10,668 m. NASA estimates that at these cruise conditions, an advanced turboprop engine with the new-design propeller would offer a 20 to 40-percent fuel saving over current turbofan engines and a 10 to 20 percent fuel saving over advanced turbofan engines.

The flight tests, scheduled for 1980, will be conducted on board a Lockheed Jetstar aircraft currently owned and operated by the Dryden center. The flight tests will be conducted at the same cruise speed and altitude as those simulated in the wind tunnel. Noise levels generated by the propeller models at cruise conditions will be measured during the tests and the results will be used in designing quiet cabins for future turboprop-powered aircraft.

A $609,000 contract was recently signed with the Lockheed Corp., Marietta, Ga, with assistance from the Tech Development Corporation of Dayton, Ohio, for the design and fabrication of hardware for the flight tests. Hamilton Standard, Windsor Locks, Conn., manufacturer of the propeller models, also will provide program support.

The work on propellers is part of a NASA-wide effort to provide the technology for a 50 percent saving in fuel in future U.S. aircraft.



Design for a New Propeller—A variety of newfangled propellers has been tested in the Langley center's wind tunnel. Shown is an eight-bladed model with an extreme curve in its blades. Tests show the propeller to be less noisy and more efficient than other models tested, and suggest that it might represent a means of saving a large amount of airplane fuel. Dan Nikkelson, head of Lewis' subsonic propulsion section, wind tunnel and flight division demonstrates the model.

Spacelab Task Assigned to KSC

NASA has decided to conduct all physical integration of Spacelab experiments related to the Space Shuttle at its Kennedy Space Center launch site. The decision follows extensive analysis and cost studies, and confirms an earlier tentative decision to perform the work at Kennedy rather than at the centers charged with managing the Spacelab missions.

Physical integration involves actual installation of the experiments on Spacelab's racks and pallets. When Spacelab operations become routine in the mid-1980s, the physical integration is expected to require about 100 civil service and contractor man-years of work each year at Kennedy.

Analytical work required to integrate experiments for each Spacelab mission will continue to be done at assigned mission management centers.

Spacelab is a scientific facility which will be installed in the payload bay of NASA's Space Shuttle for periodic missions. Scientists and technicians will conduct experiments in Spacelab on Earth orbital missions of seven to 30 days duration. Spacelab is being built by the European Space Agency.

Geological Expedition to the Egyptian Desert

A recently completed joint United States and Egyptian geological expedition into the southwestern desert of Egypt (see *Activities*, Nov. 1978) made several significant discoveries pertaining to desert erosion and sand movement.

The Egyptian desert was selected as a study site because of the similarity between that area and the Martian deserts as revealed by space photography from NASA manned and unmanned space flights.

Because the maps of the region were inadequate, the expedition made use of NASA's Nimbus-6 research satellite to track its daily route. The satellite monitored beacon signals from the expedition and reported the location of the group to the Goddard Space Flight Center.

Dr. Farouk El-Baz, research director of the Center for Earth and Planetary Studies at the Smithsonian's National Air and Space Museum, headed the trip, which was partially funded by the Smithsonian Institution.

Among the findings were many indications of the strength and erosive powers of wind. As a result of the expedition's discovery that wind is responsible for carving out holes in all the rock types found in Egypt's southwestern desert, basic assumptions made about the geological processes on Earth and on Mars are being reevaluated. Earlier assumptions were that the pits in many rocks on the surface of Mars resulted from small air pockets formed in the volcanic rock during solidification. In light of the new findings, that interpretation is being reconsidered.

Expedition findings showed that the wind digs holes in all rock types in Egypt's southwestern desert —in dense volcanic rocks such as basalts and trachytes, in coarse-grained igneous rocks such as granites, and in sandstone and quartzite. The wind creates a vortex around individual grains of stone and plucks them out of the rock. In addition, sand grains became lodged inside small pits, and repetitive wind gusts grind these grains into the rock, thus enlarging the hole.

An understanding of the law of sand movement and dune growth is considered vital by members of the group and others studying the subject. Deserts constitute a fifth of the land masses of the Earth and each year are encroaching on man's fertile soil. Tunisia, for example, has lost about half of its arable land in the last 20 years.

Though wide valleys were dug in the Egyptian desert by rainfall 100,000 years ago, in the last 10,000 years precipitation has been scanty. During the past 10,000 years changes, therefore, have been almost entirely produced by the wind.

The trip's botanist, Dr. Lotfi Bolous of Cairo University, estimated that not a drop of rain has fallen in parts of the desert for 20 years. Apparently rainfall was more plentiful at other times in the past, since human-settlements thrived in the region from 200,000 B.C. to 6,000 B.C.

In addition to El-Baz, Americans in the expedition included three geologists from the U.S. Geological Survey, another geologist from the Air and Space Museum's Center for Earth and Planetary Studies and two archaeologists from the Universities of Arizona and Kansas. They were joined by geologists from Ain Shams University in Cairo and the Geological Survey of Egypt.

The trip began in Cairo where the 17 American and Egyptian scientists were transported by air to Kharga, in Egypt's south central desert. At Kharga the scientists were met by 16 support personnel and 11 cars. The auto caravan headed towards the south and established camp at Bir Tarfawi, Egypt. It later continued to Gilf Kebir Plateau to reach the major site, Oweinat Mountain at the borders of Egypt, Libya and Sudan.

The expedition was financed by the Smithsonian Institution, Ain Shams University, the Geological Survey of Egypt, the U.S. Geological Survey, the National Geographic Society and NASA.

Launches and Space Events in 1979

Eleven of the 16 launches on NASA's schedule for 1979 are reimbursables, satellites launched by NASA for other agencies or corporations.

The space agency's activities in 1979 will include the first launch and orbital flight of the crew-carrying Space Shuttle, Jupiter and Saturn encounters by two Voyager spacecraft, and a flyby of the rings of Saturn by the Pioneer 11 spacecraft.

Three launch sites will be used: Cape Canaveral, Fla.; Vandenberg Air Force Base, Calif.; and Wallops Island, Va.

As was true in 1978, most of the 1979 launches will emphasize the use of space for the direct benefit of people on Earth in the fields of environmental and meteorological information, and communications. During 1978, the agency logged 20 launches, of which

11 were for paying customers. In 1979, paying customers include the Department of Defense, the National Oceanic and Atmospheric Administration, the United Kingdom, Western Union Corp., Comsat Corp., and RCA.

The first orbital flight of the Space Shuttle is scheduled for Nov. 9. Astronauts John Young and Robert Crippen have been named as crew members on the first flight, to be launched from the Kennedy Space Center for a landing about 53 hours later at the NASA Dryden Flight Research Center.

On March 5, the Voyager 1 spacecraft, launched from Earth on Sept. 5, 1977, is scheduled to make its closest approach to the planet Jupiter and travel on to make a close approach to the planet Saturn on Nov. 12, 1980. Its sister spacecraft, Voyager 2, launched Aug. 20, 1977, makes its closest approach to Jupiter on July 9, and to Saturn on Aug. 27, 1981.

The Pioneer 11 spacecraft, launched April 6, 1973, with its primary mission to fly by Jupiter, is scheduled to make its closest approach to the rings of Saturn on Sept. 1.

The 1979 launch schedule began with two launches on Jan. 25, one called SCATHA (for "Spacecraft Charging at High Altitudes") launched aboard a Delta from Cape Canaveral for the Department of Defense, the other a NASA applications satellite, SAGE-A (for "Stratospheric Aerosol and Gas Experiment"), on a Scout from Wallops Island, Va.

Two more launches are earmarked for April at Vandenberg: NOAA–A, a weather satellite to be launched for the National Oceanic and Atmospheric Administration on an Atlas–F, and Navy–20 for the Department of Defense.

FLTSATCOM–B, a Navy/Air Force communications satellite, goes in May, aboard an Atlas/Centaur from Cape Canaveral.

UK–6, a scientific satellite will be launched for the United Kingdom on a Scout launch vehicle from Wallops in June.

Westar–C, a communications satellite, will be launched from Cape Canaveral on a Delta in July; another communications satellite, Intelsat V–A, will be launched in August from Cape Canaveral on an Atlas/Centaur for Comsat Corporation.

One of NASA's scientific satellites, High Energy Astronomy Observatory–C (HEAO–C), will be launched in September on an Atlas/Centaur from Cape Canaveral. Another NASA applications satellite, Magsat–A, a magnetic field satellite, also is scheduled in September from Vandenberg on a Scout.

The Solar Maximum Mission (SMM–A), a NASA scientific mission, is scheduled for October on a Delta from Cape Canaveral and Navy 21, on a Scout, from Vandenberg.

In November, another communications satellite, Intelsat V–B, will be launched for Comsat Corp., on an Atlas/Centaur from Cape Canaveral.

Scheduled launches for the year will close out with two in December: a weather satellite, NOAA–B, for NOAA on an Atlas–F from Vandenberg; and RCA–C, a domestic communications satellite for RCA on a Delta from Cape Canaveral.

Presidential Recognition

Administrator Dr. Robert A. Frosch recently received the following memorandum from President Jimmy Carter:

"To Robert Frosch

"I wanted to let you know how delighted I am at the success of Pioneer Venus. Everyone who has worked on the project should feel proud.

"The data analyzed so far from the four probes which penetrated the Venusian atmosphere are extraordinary. With its high winds, thick clouds of sulphuric acid, and oven-like temperatures, Venus seems to be a truly infernal place—but one that is none the less fascinating for all that. It reminds us once again of the uniquely hospitable conditions of our own planet and of our duty to protect those conditions.

"Again, my congratulations to you and to the entire American space science community for this brilliant technical and scientific achievement.

Sincerely,

(s) Jimmy Carter"

A Look at History— from "Flyer" to Viking in Only 75 Years

"I am intending to start in a few days for a trip to the coast of North Carolina . . . for the purpose of making some experiments with a flying machine. It is my belief that flight is possible. . . ." So said Wilbur Wright in a letter written in 1900 when he and his brother Orville were still three years away from achieving their goal, and almost no one else in the world shared their belief that powered flight was a possibility.

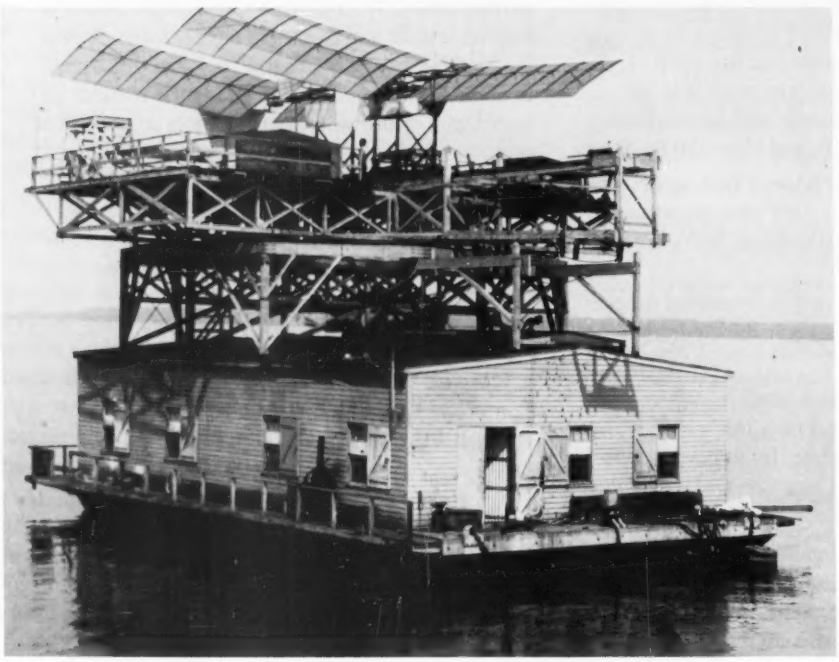
But the persistence of these two men, aided by the faith of their family and a few friends, kept them at their quiet struggle against all known odds until they succeeded in proving that man could indeed propel himself through the air in a flying machine.

For three years the Wright brothers traveled between their home-made wind tunnel in Dayton, Ohio, and the wind-swept sand dunes just south of Kitty Hawk, N.C., to experiment with gliders and what they called the "flyer." At 10:35 a.m. on Thursday, Dec. 17, 1903, at a place called Kill Devil Hills, Orville Wright (by a toss of a coin) became the first man to pilot a powered craft through the air.

Last Dec. 17th marked the 75th anniversary of the Wright brothers' achievement, a moment in time that began the conquest of the air and ultimately led humankind to leap beyond the barriers of Earth.

From that modest 12-second first lunge into the air came a change in human life so profound that neither Orville nor Wilbur Wright, with all their vision, could hope to comprehend it. But that first flight made few immediate change in anyone's life. A handful of newspapers printed the story, many people thought the Wright's claim was a hoax, and most of the world never even heard about the flight until years later. The tiny tribe of aviation enthusiasts in the United States and Europe were interested in the event, of course.

One man who had a special interest was Dr. Samuel Pierpont Langley, director of the Smithsonian Institution and an aviation pioneer. He had been trying for several years to fly his own design for a heavier-than-air craft, which he called an "aerodrome." One of his attempts to fly, which ended in frustration as his aerodrome broke in half and sank into the Potomac River near Washington, was made on Dec. 6, 1903, only 11 days before the success of the Wrights.



Forerunner of American Flying Machines—Aviation pioneer Samuel Langley called this contraption an "aerodrome" and sailed it up the Potomac River on a houseboat before launching it, unsuccessfully, in 1903.

The brothers continued to develop improved versions of their Flyer, demonstrated it in the U.S. and Europe, and gradually received recognition for their achievement. But the U.S. government did not buy a Wright plane until 1909 and, by the time World War 1 began in Europe in 1914, the U.S. had a total of 23 airplanes, ranking it far below many other nations in airpower.

In 1915, with airplanes becoming weapons of war over the trenches of France, the U.S. government established its first aviation research agency, the National Advisory Committee for Aeronautics (NACA). Orville Wright became a member of that Committee in 1920 (Wilbur died in 1912), and served until his death in 1948. After that belated beginning, the United States made strong headway in aeronautical advancements. NACA's first research laboratory, named in honor of pioneering Dr. Samuel Langley, was established in 1917 as the Langley Memorial Aeronautical Laboratory.

For more than 40 years, the Langley facility developed innovations and research methods that made airplanes fly more efficiently, with relative safety, and at greater and greater speeds. It also spawned four other research and flight centers countrywide.

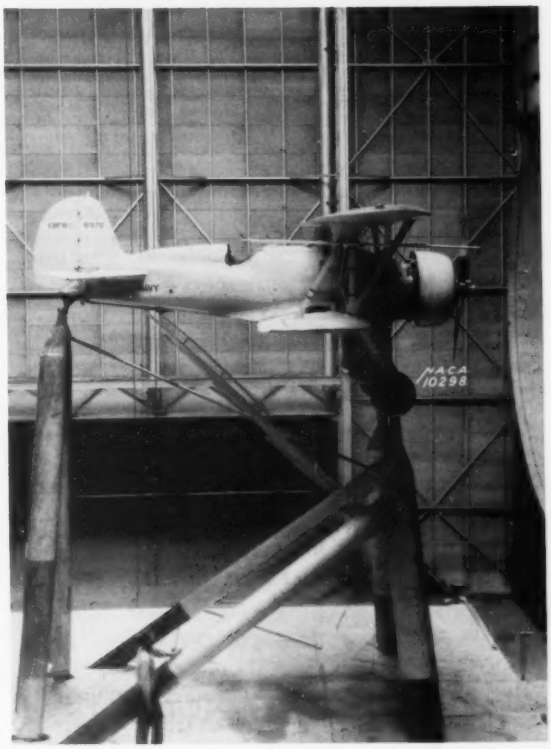
Already edging into space with the X–15 supersonic aircraft, the NACA research centers became the nucleus of America's new space agency, NASA, in 1958.

Since then, NASA's accomplishments in space have been heralded throughout the world, from the first experimental satellites, through the Apollo lunar landings, to today's planetary explorations of Mars and Venus, and to tomorrow's Space Shuttle.

But NASA's aeronautics research has continued apace. Almost every airplane flying today incorporates some facet of research born at a NASA center, and today's NASA engineers are working to make U.S. aircraft quieter, more fuel-efficient, and still safer to operate, especially in crowded terminal areas.

And two stubborn Americans, ignoring the odds and keeping fast to their dream, started it all 75 years ago on an isolated sand spit near Kitty Hawk.

Legendary Training Plane—One of two Curtiss JN–4H "Jenny" trainer airplanes just before a 1919 speed test at what was then named the Langley Memorial Aeronautics Laboratory. The Jennies helped train World War I pilots.



First Wind Tunnel—At Langley, the first variable-density tunnel was in operation in 1923. By compressing the air inside the tunnel, the dynamic scale of the models used was increased and it became possible to evaluate the lift and drag of wings in terms that corresponded well to conditions of full-scale flight.

NASA to Brief Educators

During the summer of 1979, between June 6 and Aug. 20, special briefings for educators will be held each week at the Johnson Space Center. They will take place each Monday, Wednesday, and Friday at 10 a.m., except July 20. Topics to be covered include lunar science, Landsat activities, and Space Shuttle. Free materials will be available at each session, which will last approximately two hours. Attendance will be limited to the first 35 to register for each session. Additional information may be obtained by calling (713) 483-4241 or by writing to: NASA Johnson Space Center; Attn: James D. Piondexter, Public Services Branch (AP4); Houston, TX 77058.

Book Published on Women in Aviation

The history of American women in aviation is more than the story of Amelia Earhart. In the early days of this century, women entering aviation faced all kinds of obstacles—from discriminaton in pilot school admissions to the fact that wearing trousers while flying was considered scandalous.

How they overcame these obstacles and what they contributed to American aeronautics is the subject of "United States Women in Aviation through World War I," written by Claudia M. Oakes, assistant curator of aeronautics at the Smithsonian's National Air and Space Museum.

Oakes spent eight months doing the basic research for the book, seeking to find information on the women who had been virtually unknown in aviation history, such as the early balloonists, the women who raised funds for aviation, and even those shocking women who were the first passengers in airplanes. Her research took her to the back rooms of the Museum, the Library of Congress, the National Archives and to the women themselves—Georgia "Tiny" Broadwick, the first woman to parachute from a plane, and Neta Snook, who taught Amelia Earhart to fly.

The book covers women who participated in U.S. aviation from 1880 through the first World War as supporters, passengers, designers and pilots. The 43-page paperback book is illustrated with rare photographs, documents, newspaper clippings and other archival materials from the Air and Space Museum.

The publication is the second in a series called "Smithsonian Studies in Air and Space" published by the Smithsonian Institution Press. Oakes and other curators at the Museum are planning several additional books on women in aviation: 1919 to 1929, the barnstorming years; the 1930s, the air racing era; World War II aviation, and the 1950s to present-day aviation..

The book is available for $2.50 in the National Air and Space Museum shop, Seventh Street and Independence Avenue S.W., Washington, D.C. To order, send a check for $3.25 to include postage and handling (payable to the Smithsonian Institution) to: Program Coordinator, National Air and Space Museum, Smithsonian Institution, Washington, D.C. 20560.

GE to Build Improved Landsat

The General Electric Company's Space Division, Philadelphia, has signed a $77 million contract with NASA to build Landsat–D, to be the most advanced Earth resources monitoring satellite system in history. The incentive contract cost includes a $5 million fee with additional earnings of up to $4.3 million depending upon how well the system performs once the satellite is in orbit.

Scheduled for launch in the fall of 1981, Landsat–D is the fourth in a series of experimental satellites designed to explore the Earth from more than 640 kilometers. It will have a nominal three-year mission lifetime.

In addition to the multi-spectral scanner carried by the first three Landsats, Landsat–D will carry a sensor known as the thematic mapper. It will provide a spatial resolution approximately three times as detailed as its predecessor multispectral scanners. The new sensor will be able to discriminate area features by viewing instantaneously regions of less than an acre.

The contract also calls for a backup spacecraft, a data management system, an operations control center to be located at the Goddard Space Flight Center, a transportable ground station, and a Landsat assessment system to quantify and demonstrate the advantages of the thematic mapper over the multispectral scanner.

Landsat data is used primarily for the monitoring and management of food and fiber resources, water resources, mineral and petroleum explorations, mapping of land cover, and studies of land usage.

The Landsat–D instruments and mission-unique equipment will be installed aboard a multi-mission modular spacecraft. This is a general purpose Earth-orbiting satellite bus which is being developed by NASA to supply the basic functions of power, propulsion, attitude control, communications and data handling, as well as the structure to accommodate a broad range of scientific and applications-type payloads.

The spacecraft will be designed to be retrieved by the Space Shuttle.

Expected to participate in the Landsat–D mission are such federal agencies as the Departments of Agriculture, Commerce, Interior and State. A number of states and foreign governments also will use Landsat–D data.

The Landsat–D mission will be managed by NASA's Office of Space and Terrestrial Applications with project management at the Goddard center.

New Director for TDRSS

Robert O. Aller on Jan. 2 was appointed director, Tracking and Data Relay Satellite System program office at the headquarters Office of Space Tracking and Data Systems. He is responsible for planning, direction and evaluation of the TDRSS program. Working with NASA program and project managers, Aller will determine requirements and develop and implement plans for TDRSS support of NASA Earth-orbital space flight missions.

TDRSS tracking, command, and data relay services will be provided to NASA under a 10-year telecommunications agreement with Western Union Space Communications, Inc.

Previously, Aller was deputy director, expendable launch vehicles program, in the NASA Office of Space Transportation Systems.

Since August 1964, he has served in the Apollo-Soyuz Test Project, Skylab, and with the Apollo and Gemini programs. He received the NASA Medal for Outstanding Leadership and two Exceptional Service Medals.

From July 1963 to 1964, Aller was an employee of the Philco Corp. at the NASA Johnson Space Center, responsible for developing the operational requirements and plans for the JSC integrated mission command center. From August 1953 to 1963, Aller served in the U.S. Air Force with the Satellite Test Wing and in Europe, with the Tactical Air Command.

Born in Dayton, Ohio, Aller received a B.S. degree from the U.S. Naval Academy in 1953 and M.S. degrees in Aeronautics and Astronautics from the University of Michigan in 1960.

Terrell Resigns

NASA Director of International Affairs Norman Terrell left the agency in December to join the Department of State as Deputy Assistant Secretary for Science and Technology.

Terrell joined the NASA staff in August 1977 as director of the international program policy office in the Office of International Affairs. Before joining NASA, he was assistant director for policy review in the U.S. Nuclear Regulatory Commission. Before that, he served for 12 years in the Department of State.

Richard J. H. Barnes became acting director of International Affairs after Terrell's departure.

Goddard Scientist Honored

Dr. Reuven Ramaty, chief of the theoretical group in the Goddard Space Flight Center's laboratory for high energy astrophysics, has been awarded important visiting professorships at two of the country's leading universities. During the fall 1978 semester, he will be a Distinguished Visiting McDonnell Professor of Physics at Washington University in St. Louis. For the winter quarter, he has been awarded a Sherman Fairchild Distinguished Scholarship at the California Institute of Technology in Pasadena.

Ramaty is internationally recognized for his work in solar physics and high energy astrophysics; he also is known as the leading theorist in developing gamma-ray line spectroscopy as one of the most promising new research areas in space astrophysics. He is a co-investigator on one of the experiments recently selected for definition for the Gamma Ray Observatory.

Ramaty was one of the first American scientists to receive a Senior Humboldt Fellowship from the Federal Republic of Germany.

The Skylab Story

During a press conference held at NASA headquarters in mid-December, John F. Yardley, Associate Administrator for Space Transportation Systems and Robert O. Aller, director of TDRSS, discussed at length NASA's decision to abandon plans to rescue Skylab. It is fitting that NASA employees should "listen in." A slightly abridged transcript of the proceedings follows.

John F. Yardley: Good morning, gentlemen. I would like to say this: that we in NASA are sorry to have to take this action. Skylab has been a good friend. In 1973 when we launched it, we had some trouble, but you recall that we got out of those troubles. It operated quite successfully for the eight months that we had programmed and it stayed alive for four years without any attention whatsoever.

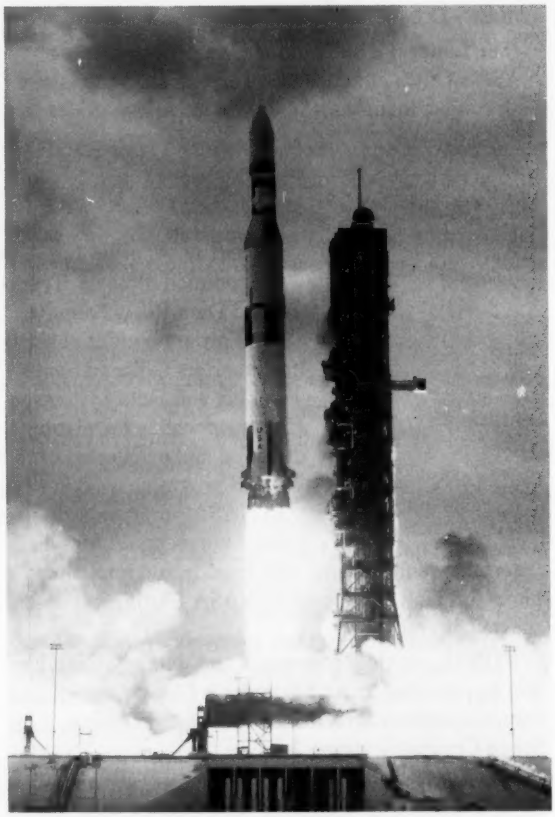
So when we got into drag trouble about a year ago it started tumbling and was making some bad predictions. We were able to activate it, get it working, get its attitude controlled. And it has been quite a tribute to the people working the program that they have been able to keep it going as long as they have.

The main problem that we have now is trying to ascertain what the odds are that we can keep it stabilized until the Shuttle gets there. In view of the original design lifetime of the subsystems and in view of the figures to date since we activated it about six or seven months ago, it would have to go another 15 to 18 months with all those subsystems working pretty much as is. There is not much more room for error or failure. That is longer than we thought a few months ago because we have slipped the Shuttle schedule. If those systems went and if the Shuttle stays on a schedule that we have now announced, we could make it, but they are awfully big "if's" there. When you put all the "if's" together, you come up with a probability of something less than one chance in 10 that we could make a successful operation.

Coupling that with the fact that our original intent was to reuse the Skylab—to get it up there where we could reuse it in the Shuttle era as a billion-dollar investment, that would be certainly worth something to us. Unfortunately, the altitude and the drag and the TRS capability no longer match a reboost capability. We could, of course, still reboost it if we could get to it, but the amount we could reboost it, together with the sunspot activities predicted, would not be sufficient to make it stable in a gravity gradient passive mode.

This means that if we reboosted it we would have to have some assurance that it would last for the year or so that we could get back to it again, or it would again be the problem of a random re-entry. And we would have spent all the money and gone through all the agony for nothing.

So we have concluded that reboost is not feasible any longer. I would wind up by saying . . . I want to personally pay tribute to Bob and the people at Marshall and the people at Johnson who have been doing this rather spectacular technical melodrama of keeping Skylab going. But we do have to consider the realities of life and have to conclude now that it is not worth it any longer.



The Six-Year Odyssey Begins—At the moment of launch from Cape Canaveral, Skylab looked good. But only a minute later, a 330-kilogram meteoroid shield was torn off and it, in turn, ripped away one solar wing and jammed the other so that it could not assume its correct position and therefore could not operate. Problems intensified rapidly as the spacecraft lost power and seriously overheated. A crash course in how to repair the complex mechanisms ensued, after which astronauts Charles Conrad, Joseph Kerwin and Paul Weitz were sent to the rescue.

Questions from Reporters

Q.: As recently as about three weeks ago you were a bit more optimistic at least on a deboost. To what extent did the Fiscal-80 budget affect the final decision and did Space Transportation Systems formally recommend the route that you are taking now or did you recommend a deboost route?

A.: My recommendation—and I don't have a calendar, but I think that it was more than three weeks ago—is that we abandon the program. As far as fiscal constraints, I would say that that is a minor part of it. It is true that—on the order of about a month ago—the reevaluation of the TRS funding requirements revealed an additional $15 to $20 million that had not yet been budgeted. But we felt that we could work out this problem if it were worth the total money. Now, you may recall that we had a requirement levied on us by Congress in the conference bill—on the conference report on our appropriation bill—it said that we had to go back to them prior to spending more than $10 million of the Fiscal '79 appropriation for this item. And we have been reevaluating for the last four to six weeks because we knew that we were going to run out of that money about now. And so it must have been three or four weeks ago that we recommended to the Administrator—that we not ask for the money and abandon the program.

Q.: Way back in the olden days I remember that there was a lot of talk about space rescue and one of the philosophies seemed to be that if we got into trouble or the Russians got into trouble, the other side would come to the rescue. Have you made any approaches at all to the Russians to see if they could do anything about this? If not, why not? And do you intend to?

A.: This is a little different from the space rescues that we had talked about. As you know, part of the ASTP program was to design docking equipment that could be prototypes of that. And we still have a long range plan with the Russians, albeit rather fuzzy, to someday have this capability. With respect to Skylab, after our ASTP and our work with the Russians, of course, we had a fairly good working knowledge of the capabilities. And at least a year ago we got our own heads together and talked about whether or not they could do anything that we couldn't do. We concluded that there are many problems that we won't go into, that it probably is not feasible so we did not ask them. However, they are being informed of what we are doing here and if they make any proposals that we haven't thought of that could be useful, we will certainly entertain them.

To the Rescue—Eleven days after launch, Skylab 2 went into orbit carrying not only the three astronauts, but all sorts of tools, devices and supplies intended to correct the seriously damaged space station. Twelve days later, following a series of daring maneuvers, including an impromptu spacewalk, the job was done.

Q.: What is the main thing that made you change your mind?

A.: I would say that there are a number of contributing factors, I might run through some of the minor ones first. The sunspot question has always been a question-mark and that has been getting a little worse in the last several months, but not a whole lot. The Shuttle schedule, of course, we reappraised two or three months ago and said that we had to slip it about six months and that, of course, meant that the subsystems on Skylab had to work longer. Now, in the six months that we have been able to track the

Skylab subsystems since we activated it, we have had a number of failures. And if you extrapolate the failures that we have had, you get a very low probability that it will last another 15 to 18 months. Now, let me give you an example, or several. The attitude control (nitrogen) gas is one. We started out with about 19,000 pound-seconds when we reactivated it. [The nitrogen is expended through small rocket nozzles of Skylab's thruster attitude control systems (TACS) to change attitude.] it is now down to 7,500 and the minimum red line is 4,000 at the time that we rendezvous, or else it will not be stable enough for the Shuttle to get the TRS to it. That gas will last if we don't need it. But the point is that since we have reactivated Skylab we have needed about 12,000 pound-seconds. Now, of course, those things were because the software wasn't quite right and a few other errors. It fell out of stabilization a few times. Now that may not happen again. But anyhow, we don't have much margin there.

In the active subsystems, the batteries on the ATM, there were originally 18 batteries when we lifted off in 1973. When we came back on line six months ago, there were 13 of these batteries. Since that time four have failed. And if we lose two more, then the control becomes doubtful and marginal. Chances are that Skylab will fall out of control and use some of that TACS [nitrogen] gas. Now, we do have airlock batteries which can back those up, but we have also lost one of those batteries in the last six months. And if you had to go on airlock batteries for your stabilization and power, you have to run the cooling systems. Well, you may recall, in the original Skylab, after four to six months one of the two cooling systems had leaked down to where it was almost inoperative. We reserviced it on the last Skylab visit and so it is full, but the other one is leaking quite a bit. So we don't believe that those cooling systems would last more than six to nine months if we had to start using them, which is a far cry from 18 months .

We could go on. There is a telemetry transmitter—one of two in the ATM—that has been hiccupping. If we lost all telemetry that would be the end. The control moment gyros have been of concern to us. We have two of them going and it takes two to keep it well stabilized. We have some software for trying it with one but we are not very confident. But one of the two gyros was actually acting up back in the original eight months. And it has started acting up again since we reactivated it.

However, through skillful technical detective work, the people at Marshall figured out what they thought was wrong. There is a lubrication problem on one of the bearings in it and if we could keep it warm, they thought it would be okay. So we pulled a maneuver several weeks ago to get it—we actually turned it around—going backwards—and that warmed it up with the particular sunning that we had. But now in the last week we have been getting these irregularities—these anomalies—even with it warm. So one would have to prognosticate that it cannot last very much longer.

Skylab after Early Repairs—Repair measures by astronauts Conrad, Kerwin and Weitz resulted in a rig consisting of a "parasol" (light-colored sheet covering upper midsection of Skylab), vital to the mission in that it protected the orbital workshop from destructive solar heat.

Q.: Mr. Yardley, a couple of questions. We have all heard you say that there is a very remote possibility that this thing could do any damage, but let's look at the other one-tenth percent. Given that possibility, what responsibility does the Agency and the U.S. Government assume? And the second question: did the White House have a final say in the decision?

A.: Let me answer the second part first. Yes, the Administrator recommended to the President that we take the action that we have decided on today, and he concurred. For the answer to the first, I would like to have our NASA General Counsel, Neil Hosenball, have a crack at it.

On the question of legal responsibility, there is an international treaty liability convention which was negotiated in 1972 under the U.N. Committee on the Peaceful Uses of Outer Space. That convention has been ratified by the U.S. with the advice and consent of the Senate. It provides for absolute liability, no proof of negligence. It sets up a Claims Commission to arbitrate the amount of damages that may be presented by the government. And, of course, in addition to the treaty itself, if any Americans were hurt, they would have rights under our own statute—whatever they might be. The court would have to decide that. So there is that mechanism. The Soviets are party to that treaty. I think about 30 or 40 countries have signed it and become parties to it. The U.S. has ratified and we are bound by that treaty.

Q.: I wonder if you could describe the—well, first of all, the current weight of Skylab or the weight anticipated at the time of reentry. And could you give us a feel for the re-entry process. Is it all going to come down? What sort of area would be affected by would be the largest, the heaviest piece that would come down? What sort of area would be effected by the re-entry?

A.: The weight in orbit, today, is approximately 157,000 pounds. We have rough techniques for attempting to predict the survival on re-entry and our estimates are between 40,000 and 50,000 pounds may survive re-entry. The entry mechanism is one in which when the vehicle is captured by the atmosphere it will begin to tumble and come apart. And the re-entry pattern we estimate to cover approximately 4,000 miles along the orbit track and as much as 100 miles—50 miles on each side of the orbital track. The estimates in the number of pieces that might survive range from about 400 to 500, from very small—a pound or two—to several hundred pounds.

Q.: Is there any estimate that the velocity at which these pieces would hit the ground—I am thinking that a one pound piece, although very small, could do an awful lot of damage if it was travelling very fast.

A.: I don't have a number for the velocity when it impacts. I think we would have to agree, depending on what the surface was that the item might strike, that it could do some damage. The velocity is certainly going to be less than 200 to 300 feet per second. It is not anything like reentry velocity. Most of them will be big pieces of skin that may be floating like leaves and that sort of thing. The heavier pieces will probably be at 200 or 300 feet per second.

Q.: The news release refers to contingency plans. Could you discuss what they are? And the second question: Do you plan to try to keep Skylab stabilized or are you just going to let it go? And, if so, what is the best estimate for time of re-entry?

A.: The contingency plans referred to are really not yet made. What we want to do is to take one more look at the total technical capability of controlling it, however slight we may have—the opportunity to do it—to see if there is anything better than just letting it free-wheel. And we also want to plan for having a standby capability to lend medical assistance or whatever is required in case something happens. We thought it was prudent to keep Skylab under control at least until we get that thought through and that is probably to the end of January. Now, if the contingency planning shows that there is some value to continue control, we would continue to control it. It is felt by the people closest to the project that there is not going to be any value in doing that, in which case, we would probably terminate it and revert strictly to the tracking as opposed to an active control of the attitude and so on. Now, if we abandon control and it went into its tumbling mode, probably around July of 1979 would be its entry date. I think we think roughly from July to September of 1979, in that timeframe.

Q.: Do you have any idea where those elements will come down that will not burn? And is there any chance that they might come down over Europe?

A.: Well, the nice thing about Skylab is that it is nondiscriminatory. The pieces will come down between 50 degrees North Latitude and 50 degrees South Latitude. So the Eskimos and the Alaskans are in good shape, but anybody else between 50 North and 50 South has just as equal a probability as

anybody else because the orbits cover all of this territory repeatedly and the precision with which we would have to pre-predict its orbit to get most of those people out of its path is precision which we can't do with one of these random re-entries.

Q.: Does that mean that you do not know where those elements—those parts will come down?

A.: Absolutely, it means that. It is just like every other decaying object from orbit. I might point out that this is not the first such event. It happens to be the biggest single orbiting body, that we know of, but several years ago we had an S–2 Stage, the one that put Skylab into this orbit, come in. It was 90,000 pounds and had five massive engines which could have been big survival items through re-entry. We never heard hide nor hair of that coming in anywhere. It came in off the coast of Africa, we think, from NORAD tracking. Recently, we had a similar situation with Pegasus, weighing about 22,000 pounds. That came in, as best we can record from the tracking, over Central Africa on land. And we heard no reports of any sightings, much less of anybody hurt. Incidentally, just to put this into perspective, it has been estimated that if the entry centered right on Washington, D.C., the likelihood would be one piece coming down somewhere in the metropolitan area. That is how widely dispersed the pieces are.

Q.: With the likelihood that some pieces may come down in a heavily populated area, has NASA considered a plan of maybe disassembling Skylab while it is in space—some kind of way—maybe even blowing it up so it will not cause any damage? Or is the expected damage so minor?

A.: We don't have a capability to disassemble it because our capability is contingent on the Shuttle getting there and we are talking about April of 1980 when we would have a real chance of doing that. Our problem is that we can't keep it up until then because the subsystems aren't going to work long enough. However, we have looked at what if we had the capability through some other means like the Russians have of an anti-satellite—of blowing it up or breaking it up. And our calculations show that the resultant amount of material that might come through the atmosphere is greater and the danger is greater than by letting it come down in one piece to a certain altitude and then break up naturally. Because, as I said, over a metropolitan area as big as Washington, D.C., we only expect to get one or two of these 400 or 500 pieces. So the density of pieces is very dispersed. It is not like you could hit a school with 1,000 people in it or something like that. It is not that kind of thing. And, of course, there are no nuclear materials on board which was a worry with one of the Russian entries a year ago.

Q.: You spoke earlier of standby medical people and so forth. And that brings to mind all sorts of scenarios like medivac units, and so forth, on standby. Is there any contingency plan for that?

A.: That is what we are working on now—what contingency plans make the best sense. In previous times we have had some alert capability to do that, but nothing that was very elaborate or very expensive. And we have never had to use it.

Q.: Granting the imprecision of predicting exactly where this thing would come down or re-enter at about what time—how long before actual re-entry would NORAD have some kind of pretty good fix on what part of the earth it would come down over?

A.: I will give you a case history. When the S–2 came in, we had a little watch—a 24-hour watch on. And NORAD predicted the orbit, one orbit ahead of time and it missed it by an orbit. Now, when you miss by an orbit, you know that is anywhere around the world on that orbit so the precision is very imprecise. The problem is that sometimes the vehicle will skip out when it hits the atmosphere rather than being captured and tumble in.

Q.: What you are talking about then is if you are lucky you might have an hour-and-a-half's notice or something like that?

A.: An hour-and-a-half ahead of the event, you could probably confine it to two orbits. Now, two orbits, while they go all the way around the Earth, they don't cover all of the Earth. Because it takes about 18 to 16 orbits to cover every spot on earth. You could confine it to an area of 12 percent of the Earth's surface between plus 50 and minus 50 but that is a pretty big area.

Q.: In the first place, from the beginning of Skylab, were the effects of drag and sunspots underestimated?

A.: We did underestimate the lifetime, obviously. At the end of Skylab in February 1974, the estimate was made by Marshall, I believe, that the lifetime should be roughly to 1983. And our plans as a result of that were based on development of the Shuttle in '79 and therefore ample time to plan a mission with Skylab. So the fact that we estimated a

year ago—a little over a year ago, that Skylab was reentering more rapidly, than predicted; and that if we did not control it it would be coming in 1979, we underestimated it.

Q.: Was the underestimation the effect of the drag and the sunspots?

A.: The underestimation was in-estimating a lower sunspot activity on this particular cycle—cycle 21, than we are actually experiencing.

Q.: Just looking at Shuttle schedule now suggests you are going to have to recycle that second Shuttle. What will you do with it now?

A.: What we probably will do, and we haven't figured all of this out, but we have been carrying this as a backup, is move the payloads forward one notch on the rest of the Shuttle flights, in general. The second flight was always a little earlier than we wanted to do Skylab because that is a pretty ambitious mission for the second flight. So it will actually give us some relief in training and other preparation activities of the Shuttle. But this would mean that in the second flight instead of the TRS and Skylab we would put what we call our applications pallet for orbital flight tests.

Q.: If the first Shuttle goes in September 1979 as scheduled, when would the next one go then?

A.: We are talking about four months between if everything goes letter perfect on the first flight. So that would be about January 1980.

Q.: It is a long list of failures that you went through before—the thing running out of gas; the batteries, aren't working; it was supposed to be—you thought it would be in orbit until 1983 or until 1984; the sunspots were underestimated. If it had stayed in orbit that long, would those batteries and the subsystems that you described, would they have lasted that long?

A.: Yes, we had a four-year storage period without the subsystems working. The only thing we had working—I guess we had one battery and one command receiver and all the other things were quiescent. Now, apparently the tumbling orbital storage with Skylab was a very benign environment because when we turned everything back on after four years almost everything worked. I don't think we had any batteries fail in that period, not in the original reactivation. So the storage period seems to be able to go for quite a while. But if you are using

Spider Celebrity—Arabella became the first spider to spin a web in the zero-gravity atmosphere of space. She was part of one of the student experiments placed aboard Skylab.

them, then the life seems to be used up, which is normal.

Q.: You mean you used up the subsystems because the thing began to come down?

A.: Yes, because when it started tumbling, the only way we could keep it up was to stop it from tumbling and so we turned it back on and set up quite an elaborate ground control scheme. We actually activated some more stations around the world. We ran five shifts a week on tracking and monitoring and active control. We found out that we didn't have enough stations and something would go wrong when it was out of sight and that is how we used up some gas, we put some more stations on line. But it took this active business and when you reflect that the equipment originally was to perform an eight-month mission, we have had it turned on now for another six or seven and it is admirable how well it has done. But when you look down the road and you have another 15 or 18 to go and you look at the failure history we had in the last six or seven months it is a very slim possibility that it is going to last that long. When we originally planned to revisit Skylab, we did not plan to activate the systems at all. We only activated the systems last spring when we realized that we had to reduce the drag on the vehicle. It was

gravity gradient stabilized and it was not tumbling until it got low enough that together with the sunspot activity this started the tumbling, about a year ago.

Q.: What has the activation effort cost so far from the time you activated until now?

A.: We have, to date, about $2 million for reactivation if we take both the tracking guys and our mission control and so on. It is about $2 million directed at keeping it alive. That is not, of course, the tele-operator development or the mission planning or training and so on for the actual mission.

Q.: How much more would you have had to spend to carry out controlling, and if you carry out the whole reboost mission—what would that have cost?

A.: For the whole mission, that means the control since the beginning, the development of the TRS, excluding, of course, any cost of the Shuttle flight—just the mission peculiars would be between $60 and $65 million. And, to date, we have spent $26 million.

Q.: Of the $26 million that has been spent so far, how much of that, in essence, is lost because you are dropping the program?

A.: Obviously, the effort gone into keeping Skylab active and planning the mission which is about $2½ million if we want to put the mission planning in there—that is lost because we are not going to do that mission. Of the remaining $24 million, which is primarily tele-operator development, some of that effort could be useful later. We do need a tele-operator. Now, the problem is the tele-operator we need, we don't really need for, say, four more years and the requirements for that tele-operator are somewhat different than this tele-operator. This one was sort of a crash program—one of a kind using leftover Viking equipment and that sort of thing. So if we had continued it we still would have had to make design modifications and build another one which was somewhat different because that equipment would not have been available. We estimate that some $10 million of the $24 million will be usable for a future tele-operator. But that is pretty much of a guess at this time.

Q.: What will happen to TRS? Will it be continued or used at any time?

A.: As I already mentioned, some of the equipment may be useful. Some of the design may be usable. What we plan to do in the next week or so is to make an intense evaluation of what we should continue and finish and put on the shelf; what we should do to get the drawings brought up to date; or whether we should not; and so on. Our intention would be to sort of bring that to a conclusion and store what we could that might be useful and then we will have some study efforts going on in the next several years to development requirements and the real tele-operator that we desire. And then we will find out how much of this is usable.

Q.: Your statement say: "Probability of injury or damage is less than from meteorites according to estimates." Whose estimates are these and give scientific justification?

A.: The ability to predict re-entry is imprecise, as we have stated before. However, we have completed a study and the study included an estimate of yearly entry of meteorites from two different scientists and compared to the re-entry wake as estimated from Skylab. The study was completed last year sometime. The result was that more meteorites re-entered and impacted the earth between the latitudes in one year that we are talking about than will with Skylab. That's in terms of weight and numbers of pieces, also numbers of meteorites. And you might add that to our knowledge there has been only one reported case in the last 200 years of anybody even being hit by a meteor, much less being hurt. There have been no fatalities reported, ever. There have been some injuries and it turns out that there are incidental injuries—I think there was one in St. Louis, a fellow driving a car. They occur about every 30 years. And it is interesting how the statistics work, but roughly, if we could say then that a Skylab was entering every year and for a 30-year period, someone would report an injury.

Q.: Given the uncertainties surrounding re-entry, how firm is your July 1979 date as the earliest possibility? Could it be earlier than that?

A.: The July 1979 date is sort of a 50 percent probable date. It could be earlier than that if the sunspots go up in the next several months and so on. If we had what we call the highest estimates at which sunspots could occur it could come in as early as May 1979. And there are factors that need to be traded off there. We are not sure exactly what drag factor we will get at lower altitudes and that drag factor affects limetime also. That is why we give a bracket of some time in our estimation between July and September.

Q.: Can Skylab be made to re-enter earlier by either changing the tumble rate using the remaining control gas or some other method?

A.: The only real control that we have right now—we have it controlled in a minimum drag configuration. But our problem is that we don't know how long we can control it. We are pretty sure we can't control it for another 15 to 18 months. If we abandon control it will begin to tumble and it will have certain drag characteristics that will bring it in as early as it could possibly be brought in. There is no way we can control it to a higher drag configuration. It just so happens, you may recall, that one of our solar wings was lost on launch in the initial Skylab launch. And that gives a dissymmetry to the configuration. And with the drag that we've got, it gives it a quite high roll-tumble rates. So that gives us a sort of a drag that is the maximum drag.

Q.: What are the largest pieces likely to come in? Would it be like the lead around the furnace or the film storage box, or what?

A.: I believe the largest piece is the airlock shroud, which was the heavy structure around the airlock. There is a film vault that is fairly large. I think those are the two larger pieces.

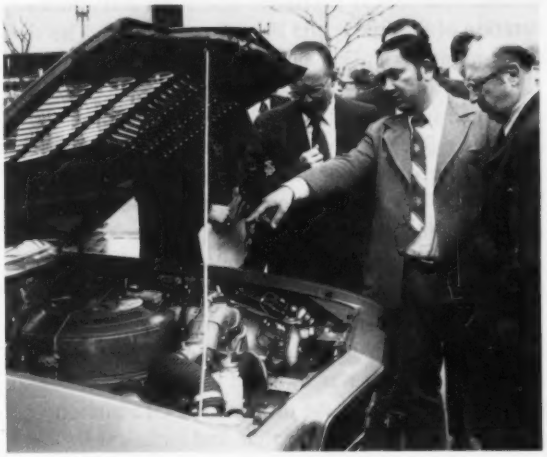
Q.: How much do they weigh?

A.: The estimate on the airlock shroud is I believe around 5,000 pounds. And the estimate is re-entry in one piece. The film vault is I believe around 4,000 pounds.

Q.: Is it possible that these two pieces could re-enter in one piece?

A.: Yes, it is possible.

Portraits of Earth—During the two Skylab missions, a voluminous file of thousands of Earth photographs was compiled, encompassing virtually the entire surface of the globe. Seen here is the snow-covered volcanic cone on a mountain in New Zealand.



New Auto Engine Under Study—Flanked by Administrator Dr. Robert A. Frosch (r.) and Deputy Administrator Dr. Alan M. Lovelace, William Tabata of the Lewis center explains a new kind of car engine from Sweden. Called the Stirling engine after its development company (United Stirling of Sweden), the engine is installed in a 1977 Opel Rekord auto. The demonstration was at headquarters in Washington, D.C. The Stirling engine is inherently quiet and practically vibration-free because it does not rely on "explosions" as does a conventional engine. Emissions are low without the need for conventional exhaust system components such as mufflers, resonators and catalytic converters. It reaches its peak efficiency at low speeds rather than at high speeds. Tabata is the project manager at Lewis.

Contractor News

Global Associates of Oakland, Calif., has been chosen to provide facility operating services at the Michoud (La.) assembly facility. The contractor's proposed cost for the five-year contract period is approximately $26.5 million. Services provided will support NASA program activity and missions of other government agencies tenanted at the Michoud facility, as well as refuse collection and telecommunications services at the Slidell (La.) Computer Complex. The operations at Slidell and Michoud are managed by the Marshall center. Tenant agencies at Michoud include Department of Agriculture, Department of Defense and Department of Commerce.

Lockheed-California Co. of Burbank has won a four-year contract to develop and evaluate in flight a new concept for modifying air transport planes by using smaller horizontal tails. Lockheed estimates the total value of the cost-sharing contract to be about $17.6 million, of which the government's share is $15.8 million, and Lockheed's $1.7 million. The Langley center will monitor the contract.

The IBM Federal Systems Division of Gaithersburg Md., has signed a supplemental agreement to its contract with the Johnson center covering Shuttle orbiter avionics software for the orbital flight test and early Shuttle operational phases. The $11.1-million supplement runs through June 1, 1980, and brings the total value of the cost-plus-award-fee contract to $105 million. Work will be performed mainly at the Johnson center, with some work done at Downey and Palmdale in California and at the Kennedy center.

The Universities Space Research Assn. of Columbia, Md., has won a $1.4-million contract modification for the continued operation and administration of the Lunar and Planetary Institute. The seven-month extension calls for the contractor to provide lunar and planetary science research services in continued support of the NASA space program objectives. Specifically, through the established and continued operation of the institute, the contractor has been able to maintain communication among foreign and domestic scientists, universities and government organizations in support of lunar and planetary research.

The American Institute of Aeronautics and Astronautics' Technical Information Services Facility of New York City was awarded a $2.3-million contract modification for the provision of information products to the NASA scientific and technical information program. AIAA will provide selected and specialized information tools and products deemed essential to the successful conduct of the total program. It also will provide worldwide coverage of the open literature that contribute to the NASA program. Significant reports of activities and events relating to continuing and proposed space programs will be acquired by the contractor, analyzed and announced in the semi-monthly issues of International Aerospace Abstracts, and stored for ready reference on magnetic tapes and microfiche.

Telos Computing, Inc., of Santa Monica, Calif., has been selected for negotiation leading to the award of a NASA contract to develop the software for the National Transonic Facility wind tunnel at the Langley center. This software involves a network of four medium-sized computers that will compose the nucleus of the NTF instrumentation complex. It will provide for collection and display of all research measurements as well as for automatic control for many of the wind tunnel test programs. The Telos company estimates the value of this cost-plus-fixed-fee contract at some $1.2 million. The work will be performed at the Langley center over a period of three years.

Award Winners—Deputy Administrator Dr. Alan M. Lovelace presents awards to six students, winners in the Nineteenth Summer Science Research Participation Program for High-Ability Secondary School Students, 1978. At far right of photo is Prof. Marylin Krupshaw, associate director of the program. Winners standing to Lovelace's right are: Hwan Sik Choi of the Washington-Lee H.S., Arlington, Va.; Andrew C. Scheiner, Winston Churchill H.S., Potomac, Md.; Susan L. Bainbridge, Thomas Wootton H.S., Rockville, Md.; Scott A. Chase, Lake Braddock H.S., Burke, Va.; Angela M. Martins, Macgruder H.S., Rockville, Md.; and David A. Fuchs, Eleanor Roosevelt H.S., Greenbelt, Md. Some 140 students participated in the program, in which high-schoolers work for summer vacations at various government agencies. Ten students, sponsored by the National Space Club, were assigned to the Goddard center.

Launches for 1979

Name	Launch Date	Vehicle	Range	Mission Remarks
SCATHA	Jan. 25	Delta	ETR	DoD R&D. Spacecraft charging at high altitude Reimbursable.
SAGE-A	Jan. 25	Scout	WFC	NASA applications satellite. Stratospheric aerosol and gas experiment.
NOAA-A	April	Atlas-F	WTR	NOAA weather satellite. Reimbursable.
Navy-20, C/U	April	Scout	WTR	DoD Transit. Reimbursable.
FLTSATCOM-B	May	Atlas Centaur	ETR	Navy/Air Force communication satellite, Reimbursable.
UK-6	June	Scout	WFC	UK scientific satellite. Reimbursable.
Westar-C, C/U	July	Delta	ETR	Western Union communications satellite. Reimbursable.
Intelsat V-A	August	Atlas Centaur	ETR	Intelsat communications satellite. Reimbursable.
HEAO-C	September	Atlas Centaur	ETR	Third high energy astronomical observatory to study highly energetic radiation from space.
Space Shuttle	November 9	Space Shuttle	ETR	First shuttle flight.
MAGSAT-A	September	Scout	WTR	NASA applications satellite to study magnetic field.
Navy-21	October	Scout	WTR	DoD transit satellite. Reimbursable.
SMM-A	October	Delta	ETR	NASA solar maximum mission satellite.
Intelsat V-B	November	Atlas Centaur	ETR	Intelsat communications satellite for Comsat. Reimbursable.
NOAA-B (call-up)	December	Atlas-F	WTR	NOAA weather satellite. Reimbursable.
RCA-C	December	Delta	ETR	Domestic communications satellite. Reimbursable.

Patents for Inventions from NASA Research

The Office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) and Employer	Title	Patent No.	Installation
Victor S. Reinhardt, GSFC Peter O. Cervenka, Phoenix Corp., McLean, Va.	External bulb variable volume maser	4,128,814	GSFC
Alan M. Title, Lockheed Missiles & Space Co., Sunnyvale, Calif.	Partial polarizer filter	4,129,357	GSFC
Anthony Giandomenico, JPL James M. Dame Pasadena, Harold Behimer Calif.	High-torque, open-end wrench	4,130,032	NLRO
Robert E. Frazer, JPL	Coupling apparatus for ultrasonic medical diagnostic system	4,130,112	NRLO
Daniel L. Flamm, Stanford Univ., Calif.	Electric discharge for treatment of trace contaminants	4,130,490	ARC
Otto Youngbluth, Jr., LaRC	Versatile LDV burst simulator	4,130,795	LaRC
Charles G. Miller, JPL James B. Stephens	Primary reflector for solar energy collections systems	4,131,336	NRLO
Henry W. Brandhorst, Jr.,/LeRC	Back wall solar cell	4,131,486	LeRC

Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

A Radiation Hazard Detector

NASA technology has made commercially available a new, inexpensive, easy-to-carry device for protection of people exposed to potentially dangerous levels of microwave radiation.

Microwaves, radio emissions of extremely high frequency, can be hazardous but the degree of hazard is not well understood. It is generally believed that low-intensity radiation of short duration is not harmful but that exposure to high levels can cause deep internal burns, affecting the circulatory and nervous systems and particularly the eyes.

The Department of Labor has established an allowable safe threshold of exposure, but people working near high-intensity sources of microwave energy—radar antennas and TV transmitters for instance—may be unknowingly exposed to unsafe radiation. That poses a personal safety problem and a problem for employers.

Monitoring devices developed earlier, which warn personnel of dangerous radiation levels, can be cumbersome and awkward to use while working. They also require continual visual monitoring to determine the extent of levels and they are relatively expensive.

In response to the need for a cheaper and more effective warning system, NASA's Jet Propulsion Laboratory developed a new, better-powered microwave radiation hazard detector. Cicoil Corp., Chatsworth, Calif., an electronic components manufacturer, holds an exclusive license for the product. Cicoil calls the unit the Micro Gard* Model 100.**

Weighing only about .11 kilograms and about the size of a long cigarette pack, it can be carried in a shirt pocket or clipped to a belt. The unit sounds an audible alarm when microwave radiation reaches a preset level—the established safe limit or some other threshold level decided by the user organization. Simple in design, it is priced well below earlier detectors.

*Registered trademark, Cicoil Corp.

**NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of its technology.

For the benefit of all . . .

NASA
National Aeronautics and Space Administration

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